

Acute mountain sickness: the “poison of the pass”

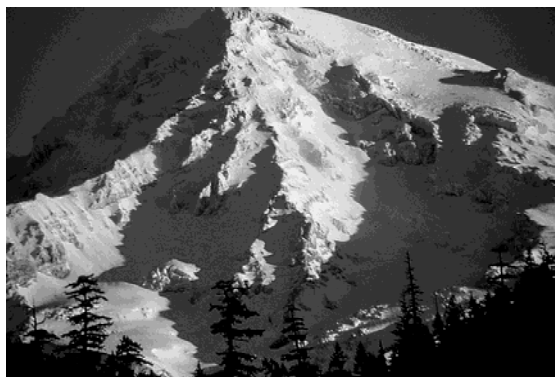
Few sights are more breathtaking and inspirational than a mountain peak. Yet, behind the innocence and majesty of one of nature's wonders lies a sleeping evil, acute mountain sickness (AMS). The constellation of symptoms that characterizes AMS is a frequent cause of morbidity and occasionally mortality and affects 25% of travelers sojourning to altitudes between 1900 and 3000 m (about 6,200–9,850 ft).¹ Joseph de Acosta, a Jesuit priest, presented the first classical account of the physical symptoms associated with mountain sickness in 1604 during a climbing expedition to Peru²:

I was suddenly surprised with so mortal and strange a pang, that I was ready to fall from the top to the ground. . . . I was surprised with such pangs of straining and casting as I thought to cast up my heart too: for having cast up meate, fleugme and choller both yellow and greene, in the end I cast up blood with the straining of my stomach. To conclude, if this had continued I should undoubtedly have died.

These early accounts of *ladrak*, a Tibetan term that literally translates to “poison of the pass,” are not far removed from complaints of frontal headaches, lassitude, insomnia, and peripheral edema experienced by modern-day AMS sufferers. These symptoms usually resolve within 4 to 5 days but, if left untreated, may progress to the life-threatening malignant forms of high-altitude pulmonary and cerebral edema. Although the precise mechanisms of AMS and its related sequelae remain elusive, a low hypoxic ventilatory drive, water retention, and increased vascular permeability are recognized as the most important pathophysiologic factors.³ Arterial oxygenation decreases as a function of the hypobaria at terrestrial altitude, and thus tissue hypoxia is considered a trigger for these changes.

The constellation of symptoms that characterizes AMS is a frequent cause of morbidity and occasionally mortality

We recently participated in a medical expedition to the world's third highest mountain (K3), Kanchenjunga (8586 m [28,169 ft]), which was designed to increase knowledge and awareness of altitude-related illnesses. Our aims were to determine the physiologic implications of AMS and to establish con-



Douglas Dickema

Illnesses are common among climbers who ascend to high altitude

stitutional risk factors that may be important in its pathogenesis. Specific attention focused on metabolic events that could result in changes in vascular permeability and the subsequent formation of edema.

Our preliminary findings raise questions about the structural integrity of muscle or cardiac cell membranes at high altitude and its role in the pathogenesis of AMS. The source of membrane damage, which may be more pronounced in subjects presenting with AMS, may be linked to an increased activity of oxygen-free radicals. Changes in vascular function at high altitude as a consequence of increased free radical-mediated oxidative stress may also prove a topic worthy of investigation in the future. Whether increased susceptibility to membrane damage as the result of a deficient antioxidant defense system is the cause or consequence of AMS and related sequelae remains to be elucidated.

Physical symptoms associated with upper respiratory and gastrointestinal tract illnesses are ubiquitous among mountaineers who ascend to high altitude. Although these illnesses may present without an infectious cause, the role of some potentially immunoprotective amino acids needs to be investigated. For example, previous accounts indicate a decrease in plasma glutamine concentrations at altitude,⁴ a conditionally essential amino acid required for optimal lymphocyte proliferation and macrophage phagocytosis.⁵ This decrease in plasma glutamine may increase a mountaineer's susceptibility to opportunistic infections. The subsequent release of vasoactive inflammatory mediators may be implicated in the pathogenesis of localized pulmonary edema, which would exacerbate arterial hypoxemia, physiologic phenomena that could account for at least some of the debilitating symptoms ascribed to AMS. We are currently conducting a double-blind placebo-controlled glutamine supplementation study in the Himalayas to explore further the possible link between infection and susceptibility to AMS.

Cachexia, which is an almost inevitable consequence of high-altitude mountaineering, may also be related to possible changes

Damian M Bailey
Hypoxia Research Unit
University of Glamorgan
Pontypridd
Wales CF37 1DL

Correspondence to:
Dr Bailey
dbailey1@glam.ac.uk

Competing interests:
None declared

A modified version of this article was originally published in *Br J Sports Med* 1999;33:376

in immunoreactivity and, although previously considered a maladaptive response, may prove to be of functional significance. The major sources of nitrogen for glutamine formation are the branched-chain amino acids, their metabolism being largely confined to skeletal muscle.⁶ A decrease in serum concentrations of the branched-chain amino acids previously observed at high altitude⁷ may signal for the endogenous catabolism of skeletal muscle to provide a constant supply of these amino acids and thus glutamine.

The use of AMS prophylactics such as acetazolamide, which functions as a respiratory stimulant by inhibiting carbonic anhydrase, has become increasingly popular among mountaineers. Alternative strategies that incorporate nutritional supplementation with amino acids and antioxidants at high altitude may also prove useful in the battle against AMS. Understanding, preventing, and treating altitude illness remain a constant challenge for the mountain physiologist.

References

- 1 Honigman B, Theis MK, Koziol-McLain J, et al. Acute mountain sickness in a general tourist population at moderate altitudes. *Ann Intern Med* 1993;118:587-592.
- 2 Jarcho S. Mountain sickness as described by Fray Joseph de Acosta, 1589. *Am J Cardiol* 1958;2:246-247.
- 3 Johnson TS, Rock PB. Current concepts: acute mountain sickness. *N Engl J Med* 1988;319:841-845.
- 4 Bailey DM, Davies B, Romer L, et al. Implications of moderate altitude training for sea-level endurance in elite distance runners. *Eur J Appl Physiol* 1997;78:360-368.
- 5 Ardawi MSM, Newsholme EA. Metabolism in lymphocytes and its importance to the immune system. *Essays Biochem* 1985;21:1-44.
- 6 Newsholme EA, Newsholme P, Curi R, et al. A role for muscle in the immune system and its importance in surgery, trauma, sepsis and burns. *Nutrition* 1988;4:261-268.
- 7 Bigard AX, Satabin P, Lavie P, et al. Effect of protein supplementation during prolonged exercise at moderate altitude on performance and plasma amino acid pattern. *Eur J Appl Physiol* 1993;66:5-10.

A book to make you think

Champion of Women and the Unborn: Horatio Robinson Storer, MD Frederick N Dyer, Science History Publications, \$39.95, pp 626

Horatio Robinson Storer (1830-1922) is a historical figure to cause indignation among supporters of a woman's right to choose contraception and abortion. He motivated the American Medical Association into a "physicians' crusade" against abortion in the United States in the 19th century. The resulting antiabortion legislation did untold harm or untold good, depending on your view, and the Supreme Court did not revoke much of it until 1973.

He was as much against contraception, holding that all available methods including "use of a sponge, cold injections, the employment of condoms or the so-called womb guard, or that worst measure of all, incomplete intercourse" contributed to uterine disease. In 1870, he discounted evidence from the Oneida community that their common practice of delayed or suppressed ejaculation was harmless.

It would be easy to dismiss Storer as an example of the repressive attitudes of his time, but he would have seen himself as a progressive, advocating the best medical care for women in a world that often mistreated them. He used his considerable surgical skill to pioneer improvements in gynecology and was the first physician in the United States to give a complete collegiate course on diseases of women as distinct from midwifery. He urged the use of chloroform to relieve the pain of childbirth and deplored the policy of refusing to admit unmarried women to lying-in hospitals. He was also a champion of the oppressed, whether black citizens or immigrant Europeans.

Storer was born into a Protestant family in Boston, although he converted to Catholicism at the age of 49. The boundaries between natural science and medicine were less distinct than now, and his father, David Humphreys Storer, was a keen ichthyologist who became professor of obstetrics and medical jurisprudence at Harvard and president of the American Medical Association (Horatio was to become vice-president). Revealing anecdotes about his famous contemporaries are delights in a biography that contains a lot of less interesting detail.

Storer seems to have been one of those people who live long and exert great influence despite apparent chronic ill health. The list of his achievements is considerable. But despite the author's best efforts, he does not emerge from these pages as an attractive figure. Every quarrel is documented, but women's voices, apart from his devoted daughter's, are almost absent.

Storer disapproved of female physicians, especially after an unhappy collaboration at an all female hospital, although he mellowed towards them in later years. He married three times, but we can only guess at his real feelings about women and what they thought of him. His first wife seems to have had a severe mental illness related to menstruation.

His descriptions of female patients are at odds with present day sympathies, which is exactly why they should be read by those with a special interest in the history of women's bodies and the eternal debate over the morality of abortion.

Jeanette Cayley

Featherstone Road Clinic, Southall, UK

This article first appeared in the *BMJ* 2000;320:80